A Biological and Economic Analysis of the North Carolina Charter Boat Fishery

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Introduction

The coastal and offshore waters of North Carolina present an ideal fishing situation for marine recreational anglers who search for a variety of pelagic and demersal species. A thriving charter boat[1] fleet of 135 boats has developed over the past 40-50 years and is now harbored at approximately 13 ports along the State's coast.

These charter vessels cater to individual or group needs. They provide full-day and half-day trips to diverse settings ranging from the Gulf Stream, 70 miles offshore, where the azure waters are hundreds of feet deep, to the shallows of sounds and small embayments where marsh grasses encroach on waters only several feet in depth. Fishermen may entice their quarry by trolling lures in open waters, by bottom fishing with squid or fish over artificial and natural reefs, or by casting cut baits in the estuaries.

While the fishing season lasts 8 months (April through November), most of the activity is by trolling in the spring and fall and reflects visitations by transient pelagic fishes attracted to North Carolina's coastal waters by a combination of water temperature, photoperiod, and the availability of food. During most of the summer, boats either fish far offshore for pelagic species or bottom fish over reefs.

Considering the size of the fleet and number of anglers participating annually, it is not particularly surprising that several surveys have been conducted on North Carolina charter boats (Rose and Hassler, 1969; Abbas, 1978; Manooch and Laws, 1979). However, these publications do not allow determination of the magnitude of the catch and effort for all segments of the fishery. Rose and Hassler (1969) reported the catch of only one species, dolphin, *Coryphaena hippurus*; Abbas (1978) conducted a primarily economic survey; and Manooch and Laws (1979) did not include catch and effort for billfishes, sharks, reef fish, or estuarine species in their 1977 survey.

In this paper we present catch and effort data by month and geographical area for all fishing categories and compare results with those obtained in 1977 (Manooch and Laws, 1979). Also, we discuss annual budgets for charter boats by district.

We believe this survey is more accurate than the 1977 study because: 1) project personnel were more experienced with goals and methods of the survey, 2) boat captains and mates were familiar with the project and were more cooperative, and 3) the 1978 survey includes catch and effort for all species and fishing categories based on a stratified sampling design.

[1]A boat for hire on a fixed daily rate regardless of the number of passengers, usually six or fewer.

ABSTRACT—North Carolina's 135 charter boats were surveyed during the 1978 fishing season, April through November, to gather information on catch and effort and profitability of the fishery. The fleet made 9,812 trips during the year: 8,449 trips trolling for pelagic fish, 1,188 bottom fishing for reef fish, 118 bottom fishing in estuaries (primarily for sciaenids), and 57 trips carrying scuba divers.

A total of 1,849,726 pounds (839.3 t) of fish representing 36 species were caught: 1,622,355 pounds (736.1 t) trolling, 220,840 (100.2 t) bottom fishing offshore, and 6,531 (3.0 t) fishing in estuaries. Major species landed while trolling were king mackerel, Scomberomorus cavalla, *bluefish,* Pomatomus saltatrix; *and dolphin,* Coryphaena hippurus. *Black sea bass,* Centropristis striata; *red porgy,* Pagrus pagrus; *and white grunt,* Haemulon plumieri, *were caught most frequently while bottom fishing offshore; flounders,* Paralichthys *spp.; weakfish,* Cynoscion regalis; *and Atlantic croaker,* Micropogon undulatus, *were the major species encountered in the estuaries.*

Species catch and catch per unit effort (number of fish caught/trip, and weight/trip) data are presented by month, geographical area, type of fishing trip, and are compared with results obtained in a similar study in 1977. Economic and related descriptive data are presented by number of trips and district. It is estimated that the fleet grossed $2,409,330 in 1978 based on charter fees alone, an average of $17,847 per boat. Gross incomes for individual boats ranged from about $1,463 to $45,580 for that year.

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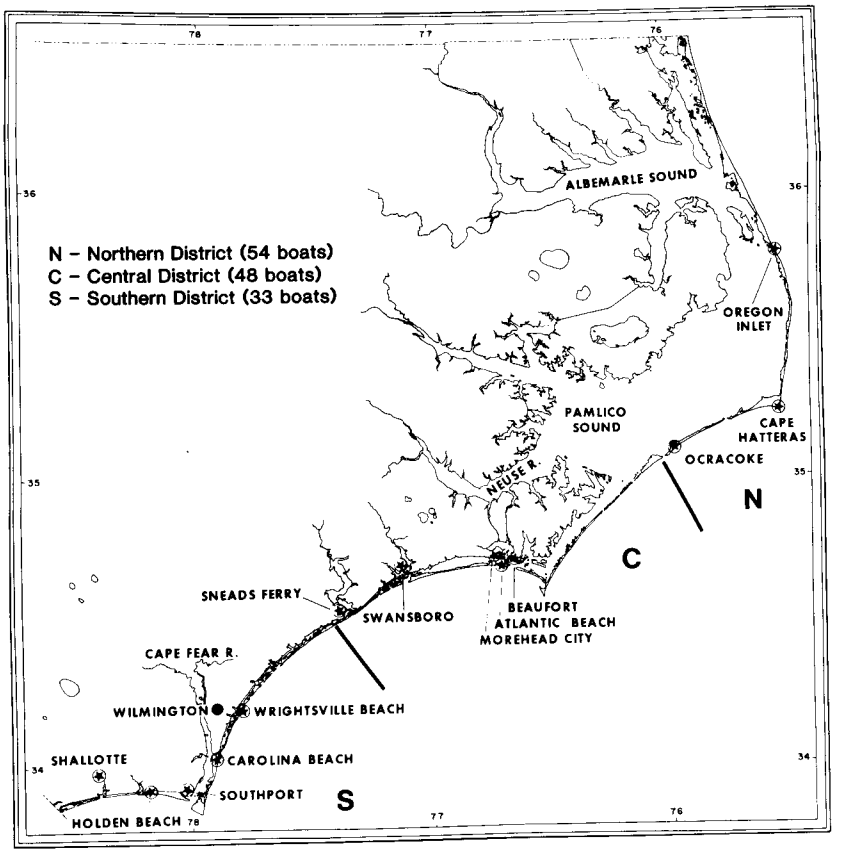
Survey Methods

The charter boat fleet was surveyed in 1978 by personally interviewing boat captains and mates. For the survey, the coastline was partitioned into three geographic strata: Northern district, Oregon Inlet to Ocracoke; central district, Harker's Island and Morehead City-Atlantic Beach to Sneads Ferry; and southern district, south of Sneads Ferry to South Carolina (Fig. 1). Three port samplers, one for each district, identified the charter boat population and made initial contacts with each operator to refamiliarize him with the goals and methods of the survey. Forms for recording daily catches were placed on each boat, filled out by the captain or mate, and picked up by the clerk at least weekly. Some boat crews were contacted daily because they failed to keep daily records but would readily provide data to the clerk for short recall periods (<1 week). Data collected for each boat included number of trips, type of trip, date, fishing locality, and number and estimated weight of each species caught. Clerks periodically sampled landings to obtain estimates of mean weight for each species.



Three North Carolina sampling districts and major charter boat ports.

In general, we followed the methods described by Manooch and Laws (1979) to estimate catch by species and catch per unit effort. We did, however, use a more stratified sampling design to obtain more accurate estimates for each type of fishing activity. The number of trips, standardized to full day, for each boat reporting was obtained, then stratified by district, month, activity (trolling offshore, trolling inshore, bottom fishing offshore, bottom fishing in estuaries, and diving). Catch per unit effort (number of fish/trip) was then calculated for each species for each effort stratum except for the dive trips. Boats known to be fishing, yet not reporting, were usually assigned mean number of trips and mean species catch per unit effort for each activity stratum in which they participated. In some instances port samplers could identify two fishing frequency strata modes: One less active, usually 2-8 trips per month; the other very active, 15-30 trips per month. Nonreporting boats could then be assigned a frequency stratum as well as a type activity stratum, which we believe increased the accuracy of this survey.

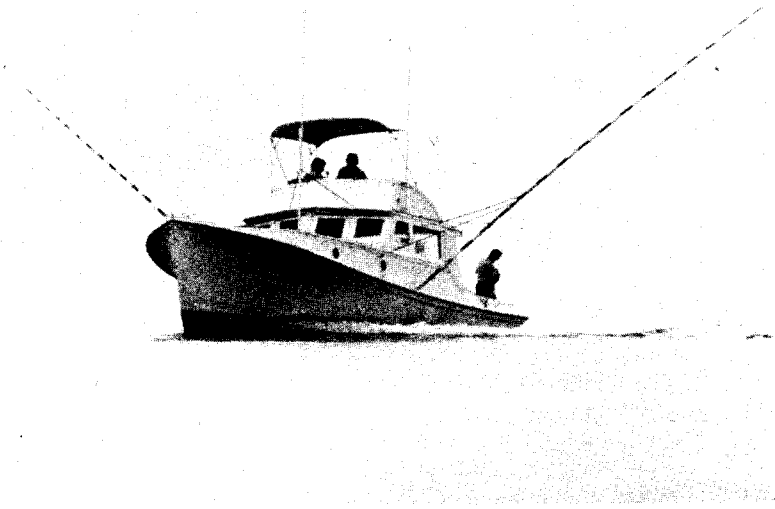
For the study of fleet economics, boats were again stratified by district, trip type, and trip frequency (less active and very active). Total receipts were calculated for boats in each district on a cost per trip basis weighted by type of trip and frequency. Variable and fixed costs were subtracted from total receipts giving net return. Net returns were calculated specifically for 1978 by taking Abbas' 1977 data and inflating each cost based upon a factor deduced from the Consumer Price Index (U.S. Department of Labor, 1978).

Results

The cooperation we received from boat captains and mates was excellent in 1978, and better than the previous year. Improvement was mainly attributable to two factors. First, the fishing constituency was more familiar with the project, and their understanding was enhanced by a report on the 1977 survey we furnished them at the beginning of the season. Second, project personnel were more experienced in conducting dockside interviews.

Overall, 83 percent of the boats in the fleet reported to the samplers. Of those fishing, 70 percent reported and provided effort information for 76 percent of the trips. Species catch data were provided for 52 percent of the trips. These excellent response percentages greatly reduced expansion factors required to calculate total catch and catch per unit effort for individual species.

The percentage of boats reporting information to the samplers varied between districts. This variation was due to accessibility of boats within a district



The *Albatross* heads through Hatteras channel.

and the availability of the sampler's time. Very seldom was a sampler denied information. In the northern district, where boats are located primarily at two ports, Oregon Inlet and Hatteras Village, the sampler was able to conduct interviews every other day. Recall periods were for only 2 days. Conversely, boats in the central and southern districts are located at many ports, each with several docking sites. This dispersion tended to diffuse sampler effort, particularly in the central district where the project coordinator served as the field sampler in addition to his supervisory duties.

Charter Boat Activities

North Carolina charter boats made 9,812 trips in 1978: 8,449 trolling, 1,188 bottom fishing for reef fish, 118 fishing in estuaries, and 57 carrying divers. The average boat made 72.7 trips from April through November.

Activities varied substantially between districts and were influenced by access to different types of fishing grounds and by preferences of the clientele. For instance, the Gulf Stream is much closer to the coastline in the northern part of the State than in the central and southern portions. Thus, more boats in the Oregon Inlet and Hatteras area fish in the Gulf Stream for pelagic species than do charter boats elsewhere. On the other hand, bottom fishing is more prevalent in the central and southern districts.

Boats in the northern district made 5,224.5 trips, 53.2 percent of the trips made by the fleet. The average boat in this district made 96.8 trips during the season. One hundred and ten trips were made to fish in the estuaries, and the others trolling: 1,402 inshore for coastal pelagics and 3,712.5 offshore for oceanic pelagic fishes. Effort was greatest in August, followed by July, and then June.

Central district charter boats made 2,784.5 trips: 1,643 trolling inshore, 426.5 trolling offshore, 705 bottom fishing for reef fish, and 10 carrying divers. The average boat made 58.0 trips during the season. Effort was greatest in October, followed by June, and then May.

The 33 boats in the southern district made 1,803 trips; 54.6 per boat for the season. Eight trips were made fishing in estuaries, 1,171 trolling for coastal pelagics, 94 trolling offshore, 483 bottom fishing for reef fish, and 47 dive trips. Most of the effort was in June, followed by May, September, and then October.

Landings

Nearly 2 million pounds (839.3 t) were landed by the charter boat fleet in 1978, representing 36 groups of fish (Table 1). Most catches were identified to species but a few such as those of sharks, groupers, amberjacks, etc., were aggregated at a higher classification level. By weight, the five most important were king mackerel, dolphin, bluefish, yellowfin tuna, and white marlin. Catch data by district and month are discussed under the following separate fishing activity categories.

Trolling Inshore

Fishermen trolling artificial lures in North Carolina's inshore coastal waters caught 17 species of fish in addition to unidentified sharks (Table 2). In all, 143,160 fish weighing 779,769 pounds were landed on 4,216 trips resulting in a catch rate of 34 fish and 185 pounds per trip. This high average catch rate is not surprising when one considers the fact that maximum catches may exceed 200 bluefish and mackerel in 1 day. Bluefish (18.8 fish/trip), king mackerel (10.9), Spanish mackerel (2.0), and little tunny (1.0) were the most frequently caught species. In fact, these four combined constituted 96 percent of the average daily catch by number. Fishes normally occurring offshore (dolphin, wahoo, billfishes, and tunas) were seldom if ever taken while trolling inshore with the minor exception of blackfin tuna landed inshore in the northern region. There, in

Table 1.—Fish caught by North Carolina charter boat anglers in 1978, ranked in order of pounds and indicating major type of fishing category.

Species	Pounds	Fishing category
King mackerel, *Scomberomorus cavalla*	446,741	Trolling
Dolphin, *Coryphaena hippurus*	274,993	Trolling - offshore
Bluefish, *Pomatomus saltatrix*	262,699	Trolling - inshore and Bottom fishing - estuaries
Yellowfin tuna, *Thunnus albacares*	151,252	Trolling - offshore
White marlin, *Tetrapturus albidus*	[1]142,844	Trolling - offshore
Black sea bass, *Centropristis striata*	141,162	Bottom fishing - offshore
Blue marlin, *Makaira nigricans*	[1]82,585	Trolling - offshore
Wahoo, *Acanthocybium solanderi*	73,603	Trolling - offshore
Amberjacks, *Seriola*	45,433	Trolling and Bottom fishing - offshore
Red Porgy, *Pagrus pagrus*	38,066	Bottom fishing - offshore
Blackfin tuna, *Thunnus atlanticus*	37,904	Trolling - offshore
Little tunny, *Euthynnus alletteratus*	37,850	Trolling
White grunt, *Haemulon plumieri*	16,606	Bottom fishing - offshore
Sailfish, *Istiophorus platypterus*	[1]16,189	Trolling - offshore
Groupers, *Mycteroperca* and *Epinephelus*	15,632	Bottom fishing - offshore
Spanish mackerel, *Scomberomorus maculatus*	12,397	Trolling - inshore
Sharks, *Carcharhinus*	10,577	Trolling and Bottom fishing - offshore
Atlantic bonito, *Sarda sarda*	9,338	Trolling
Great barracuda, *Sphyraena barracuda*	7,376	Trolling
Skipjack tuna, *Euthynnus pelamis*	7,214	Trolling - offshore
Vermilion snapper, *Rhomboplites aurorubens*	6,468	Bottom fishing - offshore
Flounders, *Paralichthys*	2,230	Bottom fishing - estuaries
Cobia, *Rachycentron canadum*	1,910	Trolling
Bluefin tuna, *Thunnus thynnus*	1,667	Trolling - offshore
Weakfish, *Cynoscion regalis*	1,307	Bottom fishing - estuaries
Gray triggerfish, *Balistes capriscus*	1,192	Bottom fishing - offshore
Atlantic croaker, *Micropogon undulatus*	1,004	Bottom fishing - estuaries
Red drum, *Sciaenops ocellata*	819	Bottom fishing - estuaries
Spot, *Leiostomus xanthurus*	572	Bottom fishing - estuaries
Bigeye tuna, *Thunnus obesus*	558	Trolling - offshore
Albacore, *Thunnus alalunga*	428	Trolling - offshore
Red snapper, *Lutjanus campechanus*	382	Bottom fishing - offshore
Longbill spearfish, *Tetrapturus pfluegeri*	370	Trolling - offshore
Frigate mackerel, *Auxis thazard*	326	Trolling - inshore
Crevalle jack, *Caranx hippos*	28	Trolling - inshore
Bar jack, *Caranx ruber*	4	Trolling - inshore
Totals	1,849,726	

[1]Includes fish that were officially caught and then released. Weights were expanded for released fish based on mean weight for each species obtained by dockside samples.

Table 2.—Catch and effort for North Carolina charter boats trolling inshore (4,216 trips) and offshore (4,233 trips), 1978.

	Inshore				Offshore			
Species	No. caught	Wt. (lb.)	No./ trip	Wt./ trip	No. caught	Wt. (lb.)	No./ trip	Wt./ trip
King mackerel	46,104	419,511	10.94	99.50	3,207	27,230	0.76	6.43
Spanish mackerel	8,267	12,335	1.96	2.92	16	62	<0.01	0.01
Bluefish	79,117	256,574	18.77	60.86	628	5,526	0.15	1.31
Little tunny	4,381	34,779	1.04	8.25	345	3,071	0.08	0.73
Atlantic bonito	2,242	7,796	0.53	1.85	460	1,542	0.11	0.36
Cobia	54	1,554	0.01	0.37	12	356	<0.01	0.08
Barracuda	384	3,881	0.09	0.92	348	3,495	0.08	0.83
Amberjack	1,948	36,553	0.46	8.67	471	8,492	0.11	2.01
Blackfin tuna	167	1,926	0.04	0.46	3,767	35,978	0.89	8.50
Yellowfin tuna	31	662	0.01	0.16	4,166	150,590	0.98	35.58
Skipjack tuna	6	48	<0.01	0.01	1,097	7,166	0.26	1.69
Bluefin tuna	2	40	<0.01	0.01	31	1,627	<0.01	0.38
Bigeye tuna	–	–	–	–	13	588	<0.01	0.14
Albacore	–	–	–	–	14	428	<0.01	0.10
Frigate mackerel	125	323	0.03	0.08	3	3	<0.01	<0.01
Dolphin	214	1,434	0.05	0.34	52,266	273,559	12.35	64.63
Wahoo	16	496	<0.01	0.12	2,691	73,107	0.64	17.27
Sailfish	–	–	–	–	444	16,189	0.10	3.82
White marlin	–	–	–	–	3,137	142,844	0.74	33.75
Blue marlin	–	–	–	–	358	82,585	0.08	19.51
Longbill spearfish	–	–	–	–	7	370	<0.01	0.09
Bar jack	2	4	<0.01	<0.01	–	–	–	–
Crevalle jack	2	28	<0.01	<0.01	–	–	–	–
Sharks	98	1,825	0.02	0.43	227	7,808	0.05	1.84
Total	143,160	779,769	33.95	184.95	73,708	842,616	17.38	199.06

April and May, the fish occurred just inshore of the Gulf Stream where the water depth ranged from 20 to 30 fathoms.

Coastal pelagics (i.e., king mackerel, Spanish mackerel, bluefish, little tunny, and Atlantic bonito) were generally caught more frequently in the spring and in the fall (Table 3). Catch rates for these species reflect their seasonal migrations. Small bluefish, sought by only a small segment of the fleet, were caught throughout the summer when the large bluefish were not available. November (21.0 fish/trip) followed by April (17.3), August (15.4), and July (12.8) were the best months for this species. Catch per unit effort for king mackerel was best in November, followed by October and May (Table 3).

Combined catch rates for coastal pelagic fishes increased from north to south. In other words, the southern district had a greater catch rate for these fishes than did the northern district, and a slightly higher catch rate than boats fishing out of the central district (Table 4). A larger proportion of the trolling effort in the two southern districts was exerted inshore.

Table 3.—Monthly catch per unit effort (number fish/full-day trip) made by North Carolina charter boats trolling in 1978 (number of trips in parentheses).

Species	April (335)	May (1,032)	June (1,485.5)	July (1,330)	August (1,442)	September (1,191)	October (1,203.5)	November (430)
King mackerel	7.20	12.11	4.14	1.21	0.74	2.82	15.92	7.11
Spanish mackerel	<0.01	0.07	0.73	0.32	2.91	2.00	0.11	–
Bluefish	17.27	7.06	7.62	12.81	15.37	2.30	3.64	21.03
Little tunny	2.78	0.58	0.15	0.18	0.22	0.54	1.17	0.82
Atlantic bonito	0.78	0.69	0.80	0.05	0.07	0.09	0.21	<0.01
Frigate mackerel	0.16	0.07	<0.01	–	–	–	–	–
Cobia	–	<0.01	0.02	0.01	<0.01	0.01	<0.01	–
Barracuda	–	0.04	0.09	0.19	0.13	0.09	0.01	–
Amberjack	0.44	0.19	0.28	0.32	0.16	0.44	0.32	0.20
Blackfin tuna	0.39	1.12	0.70	0.22	0.26	0.66	0.14	0.02
Yellowfin tuna	0.12	0.27	0.29	2.03	0.16	0.20	0.23	–
Skipjack tuna	–	–	0.07	0.30	0.23	0.23	0.01	–
Bluefin tuna	–	<0.01	0.02	–	–	–	–	–
Bigeye tuna	–	–	–	0.01	–	–	–	–
Albacore	–	–	–	–	–	0.01	–	–
Dolphin	0.54	2.78	14.53	8.93	7.27	4.34	0.26	–
Wahoo	0.05	0.13	0.11	0.31	0.64	0.79	0.10	<0.01
Sailfish	–	<0.01	0.01	0.06	0.17	0.09	0.01	–
White marlin	0.01	0.02	0.11	0.52	0.59	1.13	0.04	–
Blue marlin	–	0.04	0.06	0.09	0.05	0.02	<0.01	–
Longbill spearfish	–	<0.01	–	–	<0.01	–	–	–
Bar jack	–	<0.01	–	–	–	–	–	–
Crevalle jack	–	–	–	–	–	–	<0.01	–
Sharks	–	0.02	0.05	0.05	0.01	0.07	0.05	0.01
Total	29.74	25.19	29.78	27.61	28.98	15.83	22.22	29.19

Table 4.—Catch and effort for North Carolina charter boats in 1978, by district. Number of trolling trips were: Northern district, 5,114.5 (1,402 inshore and 3,712 offshore); central district, 2,069.5 (1,643 inshore and 426.5 offshore); and southern district, 1,265 (1,171 inshore and 94 offshore).

	Northern district				Central district				Southern district			
Species	No. caught	Weight (lb.)	No./ trip	Wt./ trip	No. caught	Wt. (lb.)	No./ trip	Wt./ trip	No. caught	Wt. (lb.)	No./ trip	Wt./ trip
King mackerel	14,839	147,515	2.90	28.84	20,559	183,496	9.93	88.67	13,913	115,730	11.00	91.49
Spanish mackerel	176	411	0.03	0.08	5,359	7,426	2.59	3.59	2,748	4,560	2.17	3.60
Bluefish	59,746	147,893	11.68	28.92	12,837	61,489	6.20	29.71	7,162	52,718	5.66	41.67
Little tunny	1,356	11,849	0.27	2.32	2,617	20,270	1.26	9.79	753	5,731	0.60	4.53
Atlantic bonito	830	2,693	0.16	0.53	533	1,589	0.26	0.77	1,339	5,056	1.06	4.00
Cobia	25	672	<0.01	0.13	33	1,046	0.02	0.51	8	192	0.01	0.15
Barracuda	120	1,081	0.02	0.21	282	2,907	0.14	1.40	330	3,388	0.26	2.68
Amberjack	296	5,338	0.06	1.04	1,537	26,653	0.74	12.88	586	13,054	0.46	10.32
Blackfin tuna	3,660	34,685	0.72	6.78	151	1,607	0.07	0.78	123	1,612	0.10	1.27
Yellowfin tuna	4,122	148,905	0.81	29.11	32	970	0.02	0.47	43	1,377	0.03	1.09
Skipjack tuna	1,055	6,930	0.21	1.35	46	276	0.02	0.13	2	8	<0.01	0.01
Bluefin tuna	32	1,657	<0.01	0.32					1	10	<0.01	0.01
Albacore	14	428	<0.01	0.08								
Bigeye tuna	13	558	<0.01	0.11								
Dolphin	48,864	253,744	9.55	49.61	2,752	15,191	1.33	7.34	864	6,058	0.68	4.79
Wahoo	2,263	60,761	0.44	11.88	377	10,791	0.18	5.21	67	2,051	0.05	1.62
Sailfish	426	15,478	0.08	3.03	15	600	<0.01	0.29	3	111	<0.01	0.09
White Marlin	3,126	142,383	0.61	27.84	10	426	<0.01	0.21	1	35	<0.01	0.03
Blue Marlin	345	78,799	0.07	15.41	6	1,614	<0.01	0.78	7	2,172	0.01	1.72
Longbill spearfish	7	370	<0.01	0.07								
Bar jack	2	4	<0.01	<0.01								
Crevalle jack	2	28	<0.01	<0.01								
Frigate mackerel	3	3	<0.01	<0.01	113	283	0.05	0.14	12	40	0.01	0.03
Sharks	194	7,135	0.04	1.40	65	1,001	0.03	0.48	66	1,497	0.05	1.18
Total	141,516	1,069,320	27.67	209.08	47,324	337,635	22.87	163.15	28,028	215,400	22.16	170.28

Trolling Offshore

Boats trolling offshore waters landed 21 species of fish in addition to unidentified sharks (Table 2). Fishermen made 4,233 offshore trips, caught 73,708 fish weighing 842,616 pounds, resulting in a catch rate of 17.4 fish/trip and 199.1 pounds/trip. As expected, the average fish was much larger than that taken inshore. Dolphin (12.3 fish/trip) was far and away the dominant species taken, followed by yellowfin tuna (0.98) and blackfin tuna (0.89). By number, dolphin represented 71 percent of the daily offshore catch, and the three combined, dolphin, yellowfin, and blackfin tunas, comprised 82 percent. With the exception of 3,207 king mackerel (only 6.5 percent of the total king mackerel catch), coastal pelagics were very infrequently caught offshore (Table 2).

Oceanic pelagic fishes generally occurred more frequently in summer and early fall landings. Highest monthly average catch rates (fish/trip) for selected species were: Dolphin, June (14.5); yellowfin tuna, July (2.0); blackfin tuna, May (1.1); wahoo, September (0.8); and white marlin, September (1.1) (Table 3).

Trolling offshore was far more productive in terms of catch per unit effort in the northern district than in either of the other two areas (Table 4). Not only is the Gulf Stream closer to Hatteras and Oregon Inlet, resulting in a higher proportion of offshore trips, but evidently a combination of physical factors, such as currents, temperature, and bottom topography, makes the northern district far more attractive to oceanic pelagic species. Approximately 93 percent of the dolphin, 96 percent of the yellowfin and blackfin tunas, 84 percent of the wahoo, and over 95 percent of the billfishes were caught in this area of the State. Oceanic pelagic fishes landed in tournaments by nonchartered boats were not included in this survey.

Inshore and offshore trolling trips combined produced an average 25.7 fish and 192.0 pounds/trip (Table 5). Mean weight for each species per trip is also included in Table 5.

Table 5.—North Carolina charter boat landings made on 8,449 trolling trips, 1978 (4,216 trips inshore, 4,233 trips offshore).

Species	No. caught	Wt. (lb)	No./ trip	Wt. (trip)
King mackerel	49,311	446,741	5.84	52.87
Spanish mackerel	8,283	12,397	0.98	1.47
Bluefish	79,745	262,100	9.44	31.02
Little tunny	4,726	37,850	0.56	4.48
Atlantic bonito	2,702	9,338	0.32	1.10
Cobia	66	1,910	<0.01	0.23
Barracuda	732	7,376	0.09	0.87
Amberjack	2,419	45,045	0.29	5.33
Blackfin tuna	3,934	37,904	0.47	4.49
Yellowfin tuna	4,197	151,252	0.50	17.90
Skipjack tuna	1,103	7,214	0.13	0.85
Bluefin tuna	33	1,667	<0.01	0.20
Bigeye tuna	13	558	<0.01	0.07
Albacore	14	428	<0.01	0.05
Frigate mackerel	128	326	0.02	0.04
Dolphin	52,480	274,993	6.21	32.55
Wahoo	2,707	73,603	0.32	8.71
Sailfish	444	16,189	0.05	1.92
White marlin	3,137	142,844	0.37	16.91
Blue marlin	358	82,585	0.04	9.77
Longbill spearfish	7	370	<0.01	0.04
Bar jack	2	4	<0.01	<0.01
Crevalle jack	2	28	<0.01	<0.01
Sharks	325	9,633	0.03	1.14
Total	216,868	1,622,355	25.66	192.01

A mate in Morehead City, N.C., washes down part of a day's catch of large bluefish.

Bottom Fishing for Reef Fishes

Boats fishing offshore for reef fish occurred only in the central and southern districts. There, 1,188 trips were made producing 215,498 fish weighing 220,840 pounds (Table 6). The average trip yielded 181.4 fish weighing 185.9 pounds. The bulk of the catch was black sea bass (75 percent by number and 64 percent by weight). Other than black sea bass, red porgy, white grunt, vermilion snapper, and groupers were caught frequently. Fishing for reef fish was slightly better in the southern district (184.4 fish/trip compared with 178.3 for the central district). The catch rates for red porgy, white grunt, and grouper were higher in the southern area, whereas catch rates for black sea bass and vermilion snapper were higher for the central district (Table 6).

We do not present data on the landings of the nonmigrating reef fishes by month. We observed, however, that more effort was exerted during the summer months when coastal pelagic fishes were not readily available and suggest that catches were therefore higher in summer.

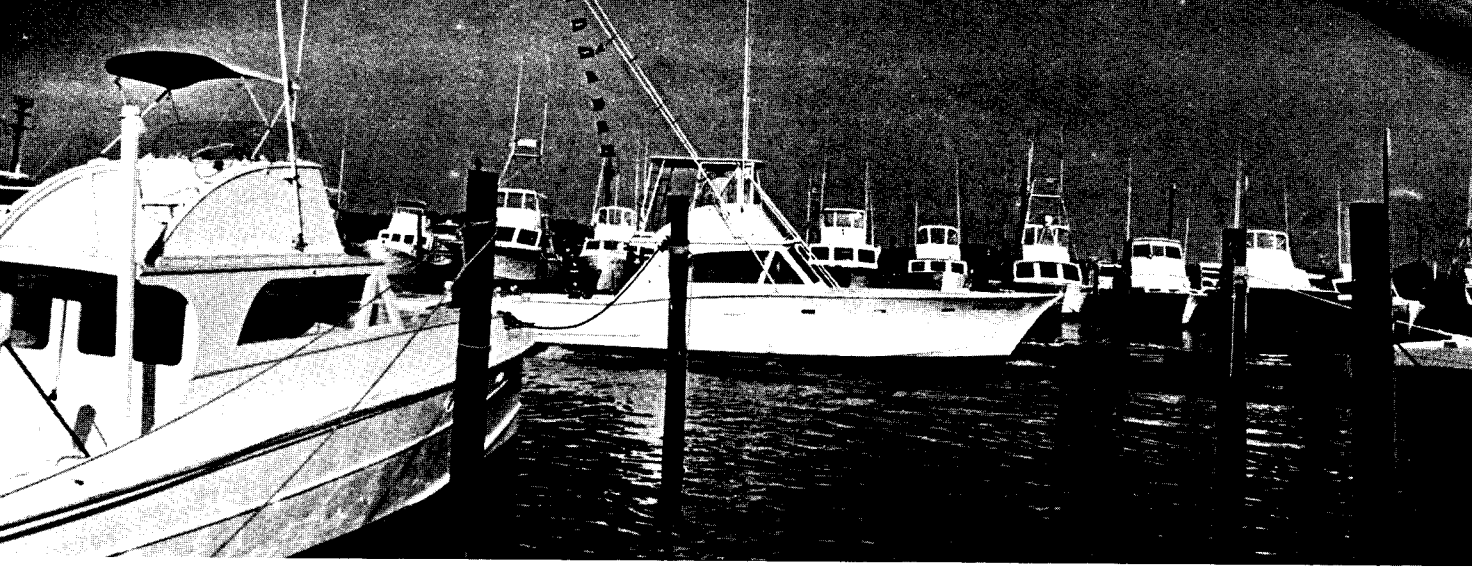
Anglers display catch of tunas, dolphin, wahoo, king mackerel, and sharks.

Fishing in Estuaries

Very few charter boats made trips to fish in estuaries. Only 118 trips were reported (Table 7). There, fishermen caught 5,809 fish, mainly sciaenids and flounders, which weighed 6,531 pounds. The average trip produced 49.2 fish, which weighed 55.3 pounds. The most frequently caught fish were Atlantic croaker, weakfish, flounders, and bluefish. No data are presented on catches of these fish by month.

Profitability of the Fleet

Gross income (total revenue) based on charter fees was calculated for the



Part of Oregon Inlet charter boat fleet.

Table 6.—Catch and effort for central district boats (705 trips) and southern district boats (483 trips) bottom fishing offshore, 1978.

	Central				Southern				Total			
Species	No. caught	Wt. (lb.)	No./trip	Wt./trip	No. caught	Wt. (lb.)	No./trip	Wt./trip	No. caught	Wt. (lb.)	No./trip	Wt./trip
Black sea bass	101,419	91,244	143.86	129.42	60,808	49,918	125.90	103.35	162,227	141,162	136.55	118.82
Red porgy	13,848	17,238	19.64	24.45	17,025	20,828	35.25	43.12	30,873	38,066	25.99	32.04
White grunt	5,091	5,869	7.22	8.32	9,208	10,737	19.06	22.23	14,299	16,606	12.04	13.98
Vermilion snapper	5,091	5,040	7.52	7.15	946	1,428	1.96	2.96	6,468	6,468	5.26	5.44
Red snapper	28	168	0.04	0.24	33	214	0.07	0.44	61	382	0.05	0.32
Grouper	323	2,273	0.46	3.22	969	13,359	2.01	27.66	1,292	15,632	1.09	13.16
Gray triggerfish	312	964	0.44	1.37	58	228	0.12	0.47	370	1,192	0.31	1.00
Amberjacks	5	63	0.01	0.09	15	325	0.03	0.67	20	388	0.02	0.33
Sharks	107	944	0.15	1.34	—	—	—	—	107	944	0.09	0.79
Total	126,436	123,803	179.34	175.60	89,062	97,037	184.40	200.90	215,498	220,840	181.40	185.88

Table 7.—North Carolina charter boat catch and effort for bottom fishing in estuaries, 1978.

Species	Number	Weight	Number per trip
Atlantic croaker	1,434	1,004	12.15
Spot	953	572	8.08
Red drum	273	819	2.31
Weakfish	1,089	1,307	9.23
Flounders	1,062	2,230	9.00
Bluefish	998	599	8.46
Total	5,809	6,531	49.23
Trips	118		
Pounds/trip		55.35	

Table 8.—Average and total revenue by district for North Carolina charter vessels, 1978.

Item	Northern district	Central district	Southern district	Total
No. of vessels	54	48	33	135
Average total revenue	25,536	13,052	12,239	17,847
Gross revenue	$1,378,942	$626,513	$403,875	$2,409,330

entire fleet and for each district (Table 8). Fees for a full-day trip ranged from $275 for fishing the Gulf Stream in the northern district, to $175 for bottom fishing in estuaries in the southern district. A total of $2,409,330 was grossed by the fleet in 1978 ($17,847/boat).

The estimated market values of vessels operating during the 1978 fishing season are presented in Table 9. Vessels in each district are separated into two classes based upon number of trips. The mean market values range from $20,583 to $48,995 with both of these extremes occurring in the northern district. Mean boat lengths vary little between district or frequency of operation class.

Correlation coefficients were obtained to determine the relationship between number of trips and boat length and between trips and boat value. Boat size and frequency of operation are positively correlated as are vessel market value and frequency of operation. Age of vessel and number of trips are negatively correlated. As one would suspect, newer and larger vessels generally have an advantage in producing revenue. Eighty-six percent of North Carolina charter boats are constructed of wood, 8 percent of fiberglass, and 6 percent of wood and fiberglass combined.

Total costs are a sum of variable and fixed costs. Variable costs result from vessel operation and increase with the number of trips. Fixed costs, sometimes called overhead, occur whether the vessel is tied to the dock or fishing. Fixed costs remain constant regardless of fishing activity.

Costs and returns for 1978 are shown in Table 10. The revenue data are from 1978 and the cost data are adjusted from 1977 using appropriate consumer price indices. Total revenues varied by district.

For instance, the high frequency category, northern district vessels received 466 percent greater revenues than those from the central district, lower frequency category.

Total variable cost was also substantially higher for vessels in the high frequency, northern district category, $17,723 versus $4,868 and $4,999 for lower frequency class vessels in the central and southern districts, respectively. This difference is explained by the greater number of trips, 46 more than the next highest category. Oil and fuel, mate services, and maintenance—the three largest contributors—accounted for 90 percent to 96 percent of variable costs. In all locations and operation classes, except the high frequency category of the northern district, maintenance was the highest percentage of variable costs.

Fixed costs do not change with the number of trips; therefore, more trips reduce the fixed cost per trip (i.e., spread the overhead). Fixed costs per trip are lowest for high frequency, northern district vessels at $32.48 and highest for lower frequency, southern district vessels at $114.41. Depreciation, the largest contributor, accounted for 29-57 percent of fixed costs. The highest depreciation was in the high frequency, northern district where vessels were newest ($\bar{x}$ = 10 years) and most valuable. Total costs were lowest for low frequency vessels. The highest total cost figure ($22,043) was from the upper mode northern district.

Net return to labor, capital, and management varied considerably. The highest net return was to vessels in the high frequency northern district ($13,258) and the lowest was to vessels in the low frequency, southern district (−$912), a loss. Vessels in the low frequency, central district incurred an average loss of $237.

Table 9.—North Carolina boat characteristics by district and number of trips, 1978.

Item	Northern district: Avg. no. of trips[1] 68	133	Central district: Avg. no. of trips[1] 34	87	Southern district: Avg. no. of trips 37	71
Est. mean market value of boat ($)	20,583	48,995	30,127	36,526	27,501	33,642
SD	24,340	39,636	28,208	22,520	23,056	19,837
Minimum value	2,000	15,000	6,000	4,000	3,000	12,000
Maximum value	90,000	150,000	90,000	100,000	60,000	65,000
Mean age of boat (years)	25	10	18	12	14	20
SD	10.8	8.4	8.8	10.2	11.3	7.4
Minimum value	new	new	new	new	new	6
Maximum value	44	26	30	38	30	25
Mean length of boat (feet)	37	45	42	44	38	45
SD	6.9	5.6	5.4	5.4	5.4	5.0
Minimum value	31	36	35	30	29	38
Maximum value	53	53	52	50	44	52

[1]Distribution of trips is bimodal; the mean for each mode is shown.

Table 10.—Annual costs and returns for North Carolina charter vessels by average number of trips and district, 1978.

Item	Northern district: Avg. no. of trips[1] 68		133		Central district: Avg. no. of trips[1] 34		87		Southern district: Avg. no. of trips[1] 37		71	
Total revenue[2]	$17,724		$35,301		$7,579		$19,521		$8,320		$15,926	
Costs												
Variable												
Oil and fuel	2,629	26%	6,384	36%	1,050	22%	2,606	26%	981	19%	2,758	31%
Booking services	137	01	287	02	68	01	293	03	0	0	0	0
Bait	646	06	1,047	06	158	03	378	04	113	02	76	1
Ice	199	02	404	02	111	02	215	01	99	02	232	03
Mate	2,541	25	4,280	24	1,276	26	3,356	33	1,130	22	2,184	25
Maintenance	4,036	40	5,321	30	2,205	45	3,337	33	2,676	55	3,549	40
Total	$10,188	100%	$17,723	100%	$4,868	99%	$10,185	100%	$4,999	100%	$ 8,799	100%
Fixed												
Insurance	$ 422	17%	$ 733	17%	$ 681	23%	$ 1,478	31%	$1,495	35%	$ 1,468	34%
Advertising	206	08	190	04	96	03	426	09	342	09	280	07
Dockage	340	14	365	08	391	13	651	13	713	17	743	17
Depreciation	1,130	45	2,481	57	1,598	54	2,009	42	1,565	37	1,269	29
Utilities	214	08	329	08	77	03	123	02	59	01	245	06
Miscellaneous	206	08	222	05	105	04	144	03	59	01	298	07
Total	$ 2,518	100%	$ 4,320	99%	$2,948	100%	$4,831	100%	$4,233	100%	$ 4,303	100%
Total costs	$12,706		$22,043		$7,816		$15,016		$9,232		$13,095	
Net return to labor, capital, and management	$ 5,018		$13,258		-$ 237		$ 4,505		-$ 912		$ 2,831	

[1]Distribution of trips is bimodal; the mean for each mode is shown.
[2]Revenue data is from 1978; cost data is from 1977 adjusted by appropriate categories of the CPI.

Discussion

Some of the results obtained in this survey may be compared directly with those from the 1977 survey (Manooch and Laws, 1979). Excluding billfish and sharks, landings made in 1978 by boats trolling were 1,370,734 pounds (162.2 pounds and 25.2 fish per trip), and in 1977, 1,568,108 pounds (197.6 pounds and 30.0 fish per trip). The average boat made 62.5 trips trolling in 1977 and 63.1 trolling trips in 1978. While the catches and catch rates for all species combined were similar for the 2 years, there were major differences in the landings for individual species. For instance, catches of king and Spanish mackerels, little tunny, and blackfin tuna were down in 1978, while catches of bluefish, yellowfin tuna, and dolphin were up. Relative to the previously listed species, wahoo were caught with equal frequency both years (0.39 fish per trip in 1977 and 0.32 fish per trip in 1978).

Two other studies, each targeted at a single species, provide estimates of the North Carolina charter boat landings for dolphin in 1961 and 1962 (Rose and Hassler, 1969) and wahoo for 1964 to 1972 (Hogarth, 1976). Charter boats landed 35,050 dolphin in 1961 and 68,007 in 1962. Since effort had essentially doubled in 1962, they estimated that the average charter boat landed approximately 700 dolphin. The total landings for dolphin in 1978 were 52,480 fish and 274,993 pounds. While the average boat in 1978 landed only 389 fish, the bulk of

A white marlin is brought on board by mate John Bayliss.

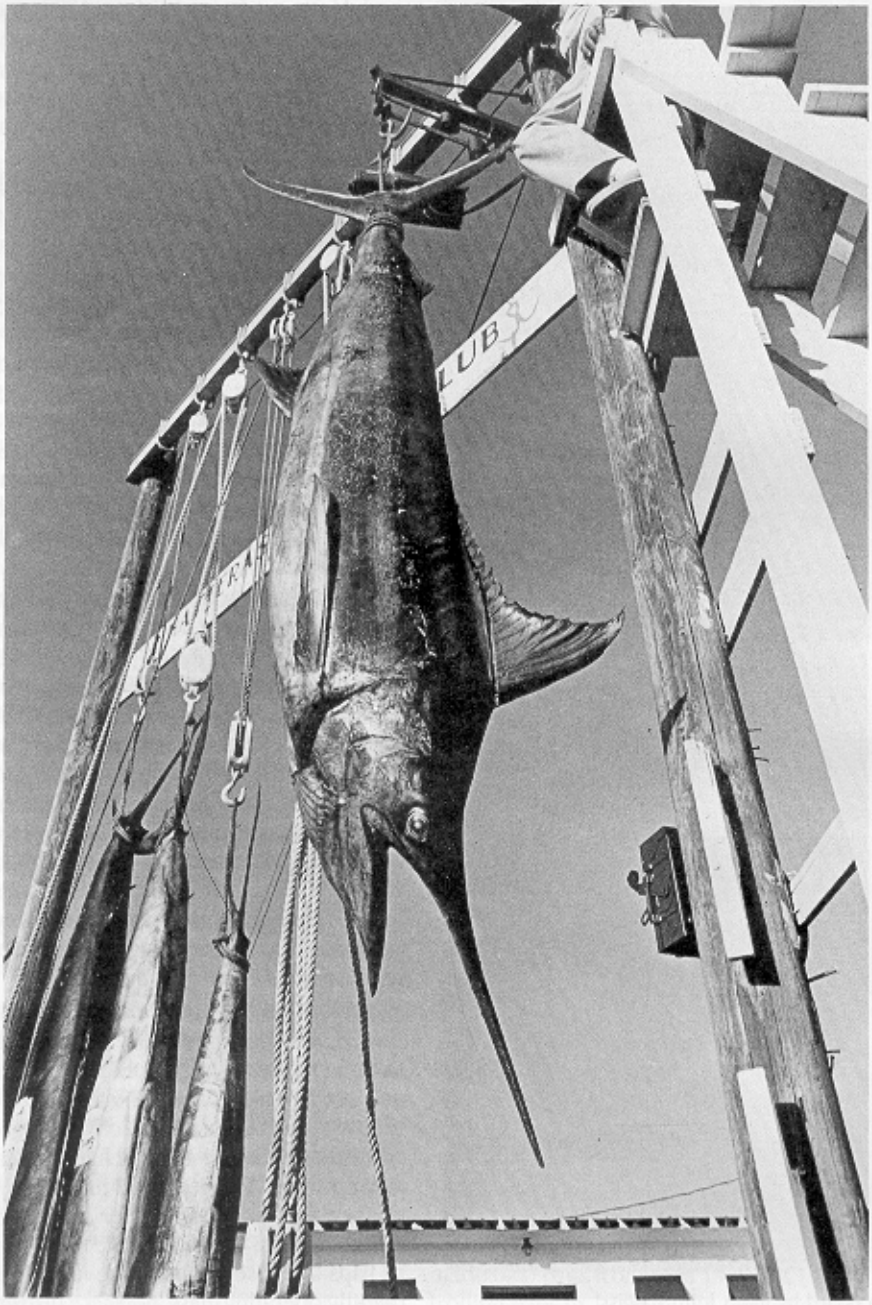
the catch for this species was made in the northern district where the average boat there caught 922 dolphin for the season. Boats trolling offshore out of Hatteras and Oregon Inlet caught an average of 17.8 dolphin per trip in 1961 (Rose and Hassler, 1969). Charter boats fishing the same areas in 1978 caught an average of 13.1 dolphin per offshore trip. The effort has almost tripled: 1,383 trips in 1961 and 3,712.5 trips in 1978.

The catches of wahoo have apparently increased over the years. Hogarth (1976) reported landings at Oregon Inlet and Hatteras from 1964 to 1972 and found an average 0.23 wahoo caught per offshore trip. The last year of his study, the catch rate was 0.37 fish. For the same areas in 1978 the average boat caught 0.61 wahoo per offshore trolling trip.

Our reported "landings" of billfish (3,939) may seem inflated even though a large percentage were officially caught and then released at sea. Abbas' survey provides the only available data that may permit us to evaluate the magnitude of the billfish landings. His total landing weights for each species were divided by the mean weights we obtained by dockside sampling (Manooch and Ross, 1979) to estimate the number of fish brought to the dock. The estimated 1977 billfish catch was 1,680 fish and the 1978 catch was 1,500.

Bottom fishing for reef fish is becoming more common from charter boats. Boats in 1977 made 980 trips, 7.7 per boat, and landed 172,189 pounds, or 175.7 pounds per trip. In 1978, 1,188 trips were made, an average of 8.8 per boat, resulting in a catch of 220,841 pounds (181.4 pounds per trip). As fishing for coastal pelagics became less productive in 1978, more of the central and southern districts' boats pursued this form of angling. This trend will probably continue if coastal pelagic species remain scarce.

Substantial variation exists between the economic regimes of vessel operations in different geographical districts and activity categories. The average return to vessels in the more active category, northern district is much higher than other groups. The vessels in this category are newer and have higher estimated market values. While variable costs rise as trips increase, boats in the more frequently operating class, northern district had many more trips than boats in other districts and classes, resulting in much higher revenues and substantially higher net returns. We see two possible reasons why net returns are substantially greater for northern district charter boats. First, net returns include a return to capital. The average northern district vessel in the high frequency of trip category is $48,995 (Table 9), which is $12,469 greater than the next highest category—high frequency vessels, central region. Addi-



A rack of blue marlin at the Hatteras Marlin Club.

tionally, there is a positive correlation between boat value and frequency of trips. This positive correlation may be explained, in part, by newness of the vessels (Table 9). "Newness" may be interpreted by potential customers as meaning safety, comfort, speed, and fishing effectiveness, thereby resulting in a shift in demand for trips on these vessels and therefore a short-term increase in revenue.

The second reason for greater profitability is related to geographical location. The demand for charter boat services is derived from the demand for offshore fishing. Port location has a large influence on the number of trips the boat captain may expect to charter during a season. In the northern district, vessels have the advantage of proximity of the Gulf Stream. Anglers can fish for large oceanic pelagic fishes within 2 hours after leaving the dock. The proximity of the Gulf Stream to the port results in short runs to fish and correspondingly longer fishing time. Another advantage to the northern district fleet is that tourists are concentrated along the very narrow strip of land, the Outer Banks, with charter boat facilities easily available.

Additionally, there are few private boats in the northern district capable of safely fishing in the Gulf Stream, thereby less competition for the charter fleet. The result is once again a tendency to shift the demand function to the right and also to be relatively more inelastic due to the uniqueness to the area. The combination of more trips and higher prices results in more revenue. The relatively large number of trips results in lower costs per trip, i.e., spreading the overhead, thereby increasing net profit.

Boats farther to the south have proportionally longer runs to the Gulf Stream, consume more fuel, and offer shorter fishing times. Therefore, these vessels tend to offer a wider variety of inshore angling, in addition to occasional diving trips. However, fishing inshore and in protected waters is not as attractive to many charter boat customers as is Gulf Stream fishing. The nearshore trips can be made easily and inexpensively in smaller, privately owned craft resulting in less demand for charter services.

The difficulties one encounters attempting to analyze marine recreational catch data for only a short period of time (in our case 2 years) are numerous. While total pounds landed and total catch per unit effort have varied little, fluctuations in catch rate for individual species may be great. The highly migratory pelagic fishes are good examples. Could we suggest that because North Carolina charter boat landings of mackerels were down in 1978 that the populations were at lower levels of abundance? Surely not. Perhaps fishermen in other

Deep sea action is shown in the faces of this New York family reeling in a white marlin.

areas experienced better than average catches for those species during the same time interval, and for some unexplainable reason, mackerels did not visit the coastal waters of North Carolina as they had the previous year. Overfishing maybe, but maybe not. The importance of a national or regional marine recreational fisheries survey is underscored. The North Carolina charter boat surveys have provided valuable information. Their intensity should guarantee accuracy, thus they can serve to test the reliability of regional surveys. And, our surveys have contributed valuable information to the State of North Carolina where the charter boat fleet is a valuable industry that grosses millions of dollars annually and furnishes recreational enjoyment for thousands of people.

Acknowledgments

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